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AUTHOR Snowman, Jack; Cunningham, Donald J.
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ABSTRACT

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The Role of Stimulus Concreteness and Visual Attentional Training in Children's Pictorial Paired-Associate Learning [1]

Jack Snowman
Southern Illinois University
Donald J. Cunningham
Institute for Child Study
Indiana University

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Abstract

Ninety-nine preoperational stage children learned 24 pictorial paired-associates at one of three levels of concreteness: low detail line drawings, high detail line drawings, high detail line drawings with a verbal prompt. Within each of these groups, one-third of the subjects received either visual attentional training, no training, or were engaged in an unrelated activity. Recognition of the appropriate response member was the main criterion. The results supported Evertson and Wicker's (1974) notion of a concreteness continuum along which pictorial stimuli can be ordered. The attentional training factor was not significant indicating that the visual attention of preoperational stage children could not be improved using the methods employed here.

The Role of Stimulus Concreteness and Visual Attentional Training in Children's Pictorial Paired-Associate Learning

The last several years has seen a flurry of research activity in an area of children's learning that has been variously referred to as pictorial, iconic, imaginal, and figurative (e.g., Bruner, 1964; Elkind, 1969; Paivio, 1970; Piaget & Inhelder, 1971; Reese, 1970; Rohwer, 1970, 1973).

Each of these formulations suggests that the study of iconic or pictorial learning is highly relevant to an understanding of children's basic cognitive processes. Moreover, Robert Thorndike (1975) has found that preschoolers of the present generation score, on the average, ten points higher on the Stanford-Binet than preschoolers of the 1930's with most of the gain attributable to performance on pictorial, perceptual, and memory items. As a result, current research has sought to identify those factors which influence how children encode, store, and retrieve pictorial information, largely through the paired-associate learning (PAL) paradigm. However, several variables which are theoretically linked to the study of children's pictorial PAL have not always been well controlled or fully investigated.

One such variable is developmental stage. Most of the investigators in children's pictorial PAL have organized subject samples on the basis of age or grade. A more reasonable, and theoretically meaningful alternative would be on the basis of cognitive stage, particularly Piaget's preoperational and operational stages. There is sufficient evidence to show that preoperational stage children deal primarily with the surface aspects of visual stimuli rather than their invariant underlying features (Bruner, Olver, Greenfield, et al., 1966; Spitz & Borland, 1971).

A second variable, stimulus concreteness, has been touched upon by Evertson and Wicker (1974) and Rohwer (1970), among others.

Evertson and Wicker (1974) have noted that prior studies used line drawings on the assumption that being pictorial they could be treated as concrete stimuli and be expected to arouse imagery. However, they felt this assumption was less appropriate for younger than older children because younger children may not yet have acquired the ability to interpret such symbols. They postulated a concreteness continuum ranging from line drawings through photographs to three dimensional objects based on increasing perceptual similarity to the particular referent and decreasing variability (or increasing restrictiveness) in visual encoding. For both nursery school children and first graders, they found objects and photographs surpassed line drawings in a PAL task and did not differ significantly from each other.

While impressive, these findings are not unchallenged. Lippman and Shanahan (1973) argued that it is more important for an imaginal mediator to be relevantly detailed than richly detailed so as not to distract the subject from the task at hand. Comparing kindergarten, second, and fourth grade students, they found strong support for this hypothesis. Holyoak, Hogeterp, and Yuille (1972) also found higher levels of performance for low over high detail pictures.

Rohwer (1970) and others (Davidson & Adams, 1970; Davidson, Perry, & Baker, 1974; Jones, 1973) have found that the addition of a verbal prompt to pictorial pairs produces better retention than pictorial pairs alone. However, this finding has not been consistently replicated. For example, Rohwer, Lynch, Suzuki, and Levin, (1967) found no difference for verbally and pictorially prompted pairs while Levin, Davidson, Wolff, and Citron (1973) found equal facilitation for sentence generation, imagery generation, and sentence plus imagery generation instructions.

The inconsistency of these findings may be due to one or more of the following factors: the subjects were of different cognitive stages, the stimuli may not have been as concrete as the experimenters thought, the response mode was not always congruent with the stimulus mode, and there was some experimenter labeling of stimuli prior to the treatments to insure familiarity.

A third variable, attention, has not been specifically investigated but has been mentioned by some in post hoc explanations of their findings(e.g., Goldberg, 1974; Jones, 1973; Lampel, 1973). Findings from eye movement studies (e.g., Mackworth & Bruner, 1970; O'Bryan & Boersma, 1971; Vurpillot, 1968; Wickens, 1974) show that children six years of age or younger generally scan only a limited part of a display using an inefficient strategy. Thus, it might be possible to control the child's perceptual behavior through a training regime and, as a result, his encoding of pictorial stimuli. Such a strategy was successfully employed by Henning and Kornreich (1971) who found that tracing pretraining facilitated recognition of familiar line drawings with three to seven year old children.

The present study, then, attempted to explore the effects of altering attentional behavior and concreteness levels of pictorial stimuli on preoperational stage children. Three levels of pictorial concreteness (low detail, high detail, and high detail + verbal prompt) were used to further evaluate the validity of Evertson and Wicker's (1974) continuum, the findings of Lippman and Shanahan (1973), and the findings by Rohwer (1970) and others that pictorial stimuli are best learned in the presence of verbal prompts.

To date, Evertson and Wicker's findings have been based on a comparison of detailed line drawings, photographs and objects. The present study attempted to extend this continuum downward. Low detail line drawings should be even less similar to their referents and more variable in encoding than the same drawings

with more detail.

To avoid the possible contaminating effects mentioned earlier, subjects were empirically determined to be within the preoperational stage of cognitive development, experimenter labeling of stimuli prior to treatment was avoided, and congruence was established between stimulus mode, retrieval cue, and response mode through a recognition criterion.

Method

Materials

A pool of 90 high detail pictures comprised of objects that were likely to be familiar to the subject sample was constructed. From this pool 48 items were randomly selected and paired for the learning set. The pairs were shown interacting in some way (i.e., frog riding on a tiger). Naturally occurring or high association pairs were eliminated. Each pair was drawn by hand once and then a second time deleting as many non-criterial details as possible. Thus, two sets of materials were devised so that, relative to each other, one had a high amount of detail and one had a low amount of detail. The pairs were then made into positive black and white slides.

For the criterion test, a 24 page booklet was prepared. On each page the stimulus member appeared at the top and in the center while the correct response and two distractors (one intralist, one extralist) appeared directly underneath. The intralist distractor was the response member from one of the other 23 pairs. The extralist distractor was randomly selected from the original pool of items. The position of the three response alternatives was counterbalanced so that each appeared in each position equally often.

Subjects and Design

The subjects were 99 kindergarten children from one school whose average age was 66 months. Using selected tasks from the Concept Assessment Kit (Goldschmid & Bentler, 1968), each child was identified as being within the preoperational stage of cognitive development. The children were run in groups of three or four. Assignment to treatment was randomized with the restriction of equal cell sizes.

The design constituted a 3 x 3 completely crossed factorial. Level of Concreteness (low detail, high detail, high detail + verbal prompt) and Attention (trained, untrained, control) were the two between subjects factors. The major criterion was the number of response members that were correctly recognized as being associated with their stimulus members. Protocols were also scored for number of intralist and extralist intrusions.

Training session. Prior to viewing the learning set, subjects either received approximately 20 minutes of training in how to view pictures so as to recognize them better, viewed these same pictures for the same amount of time with no training, or performed an unrelated activity (chatted with the experimenter) for the same amount of time.

During the training session, slides of single objects were projected on to a screen. Subjects in the training groups were instructed to pay close attention and follow with their eyes as the experimenter outlined each object with a pointer proceeding from front to back or top to bottom. With high detail pictures both the outline and inner detail were covered. Following this, each child was rated on the extent to which the pictures were adequately traced. For subjects in the high detail + verbal prompt group, the training stimuli were orally labeled as they were pre-

sented. Before leaving the training session, the subjects were reminded that they would see more pictures later that they were to look at in the same way.

The untrained groups were told they were going to see pictures of different things and to pay close attention to them. They were also told they would see more pictures at a later time. Once again, subjects in the high detail + verbal prompt group were given labels for the pictures.

Over the course of the experiment, the trained subjects were run first, untrained second, and controls last. Within these groups the order of Level of Concreteness was counterbalanced. For each group the elapsed time between training and learning sessions was 40 to 45 minutes.

Learning session. Trained subjects in the low and high detail groups were told they would see pictures of two things doing something together and they were to look at these pictures the same way as they did the others--from top to bottom and front to back, trying to remember everything they saw. No mention was made of a test. Subjects in the high detail + verbal prompt group were additionally informed the experimenter would tell them something about each picture. As each pair appeared on the screen the experimenter orally provided a sentential description of the picture. For example, "The apple is riding on the horse."

Untrained and control group subjects were told they were going to see some pictures of two things doing something together and they should try to remember these pictures by paying close attention. Subjects in the high detail + verbal prompt group were given the same sentential descriptions described above.

For all subjects, each of the 24 pairs was presented for five seconds with

an interstimulus interval of two seconds. Immediately following exposure of the last pair a five minute interpolated task was begun (writing the letters of the alphabet).

Test Session. Immediately after the interpolated task, a recognition test was administered. The subjects were shown the test booklet and told that on each page they would see four pictures, one on the top and three on the bottom. They were then reminded that they had seen one of the three before with the one on top and to draw a circle around it. To reduce the possibility of copying, the children were seated at different desks. The test session was self-paced.

Scoring. Each child's booklet was initially scored for number correct according to a strict and lenient system. For the strict scoring, only the first response counted. For example, if an incorrect response was initially made, erased, and a correct response made, the item was scored as incorrect. By the same token, a correct response which was subsequently rejected was still scored as correct. For the lenient scoring, only the last response counted. Each booklet was also scored for number of intralist and extralist intrusions. Since the results from these two scoring systems produced identical results, only those using the strict criterion will be reported.

Results

Number Correct

A 3 x 3 analysis of variance with number correct as the dependent measure revealed that Level of Concreteness, $F\ (2,90) = 3.83$, $p < .025$, was highly significant while Attention, $F\ (2,90) < 1$, and the Level of Concreteness x Attention interaction, $F\ (4,90) < 1$, were not.

An inspection of the means for Level of Concreteness revealed that high detail pictures with a verbal prompt were learned best, high detail pictures next, and low detail pictures worst. A Newman-Keuls analysis ($p < .05$) revealed that low and high detail pictures did not differ from each other although high detail pictures with a verbal prompt were superior to both. As can be seen from Table 1, there was a fairly high degree of within groups variance.

Insert Table 1 about here

Intralist Intrusions

Using number of intralist errors as the dependent variable, a second 3 x 3 analysis of variance was performed. The same pattern of results was obtained as with number correct. Once again Level of Concreteness was significant, $F\ (2,90) = 3.12$, $p < .05$, while Attention, $F\ (2,90) < 1$, and the Level of Concreteness x Attention interaction, $F\ (4,90) < 1$, were not.

The fewest number of errors were made in response to high detail pictures with a verbal prompt, somewhat more to high detail pictures, and the greatest number to low detail pictures. A Newman-Keuls analysis ($p < .05$) produced the exact results as for number correct.

Extralist Intrusions

Using number of extralist errors as the dependent variable, a third 3 x 3 analysis of variance was performed. This time a slightly different pattern emerged. Level of Concreteness approached significance, $F\ (2,90) = 2.83$, $p < .10$, as did Attention, $F\ (2,90) = 2.50$, $p < .10$, while the interaction remained nonsignificant, $F\ (4,90) = 1.35$, $p > .10$.

The ordering of the means for Level of Concreteness remained the same as

before as did the results of the Newman-Keuls analysis ($p < .10$). The direction of the means for Attention was somewhat contrary to expectations. As expected, the control group made the most errors. However, the untrained group made fewer errors than the trained group. A Newman-Keuls analysis revealed the difference between the control group and the untrained group tended towards significance ($p < .10$).

Discussion

The general hypothesis of Evertson and Wicker (1974) that different types of pictorial representation arouse imagery differentially received partial support from this study. Although increased pictorial concreteness, defined here as increased perceptual similarity to a referent, did result in increasingly higher levels of learning, performance with low and high detail pictures was statistically equivalent. As Table 1 shows, there was a fairly high degree of within group variance on this factor which obviously contributed to the lack of significance between low and high detail pictures. The fact that some children went through the test booklets rather impulsively may have had an impact. Perhaps an attempt should be made to control for this in the future.

The clear superiority of the verbal prompt condition is consistent with Rohwer's findings and suggests that for children who have not yet become proficient language users, the addition of a verbal prompt may serve to further concretize the pictures making them more amenable to imagery encoding. A recent study by Roth and Rohwer (Note 1) indicates that this effect has its locus at the associative stage of PAL.

A similar study with adult subjects (Nelson, Metzler, & Reed, 1974) comparing photographs, embellished line drawings, and unembellished line drawings

produced no significant differences and suggests an explanation as to why the present findings are in opposition to those of Holyoak et al. (1972) and Lippman and Shanahan (1973). It is possible that upon reaching the concrete operational stage amount of detail ceases to be a salient factor in pictorial learning due to the increased conceptual abilities of the learner. In other words, as the perceptual mode of representation becomes less dominant and the learner can focus on underlying invariant features, "a picture is a picture is a picture." Since Holyoak et al. (1972) and Lippman and Shanahan (1973) organized their subject samples solely on the basis of grade, it is likely that their treatments were not homogeneous with respect to cognitive stage. Future research in this area should recognize that it is not sufficient to distinguish between "younger" and "older" children on the basis of some arbitrary designation such as age or grade level. Account needs to be taken of the cognitive processes demanded by the task and the cognitive abilities of the subjects.

The failure of the attentional training hypothesis seems to indicate that the performance of preoperational stage children on a pictorial PAL task cannot be improved by manipulating their visual attention using the methods employed here. There are at least two classes of explanations which suggest themselves but which cannot be evaulated with the present data.

First, the training procedure may have been inadequate from two standpoints. Despite some promising pilot data, expecting a significant increase in learning from a single brief training session may have been unrealistic. Since there was sufficient room for improvement in the test, a longer training session,

perhaps 20 minutes a day for one week, may produce the desired results. The training may have been qualitatively inadequate as well despite the success of Henning and Kornreich (1971). Since the learning task employed picture pairs and the criterion test demanded visual discrimination, the training task might have incorporated these same characteristics.

Second, novelty or incongruity may have played a role. The random pairing of the items produced some rather novel and incongruous pictures (such as an alligator biting the tire of a car) which the children reacted to very strongly. Spontaneous laughter and comments such as "That's silly" or "That's the funniest thing I ever saw" were rather common. If this had the effect of overpowering any training effects it would not be too surprising. Lewis (Note 2), for example showed three to five year old children prictures of this type and found that attention was an increasing function from familiar to incongruous to novel stimuli. Although a realted effect, bizzareness, was ruled out of adult pictorial PAL by Wollen, Weber, and Lowry (1972) this appears to be a variable worth pursuing with children.

The fact that extralist errors produced some near significant results, albeit in the wrong direction, suggests that this may be a more sensitive criterion than number correct with studies of this type.

In sum, the attentional training hypothesis deserves farther study mainly because the relevant theoretical literature suggests it as an important aspect in young children's learning. Stevenson (1972), for one, has noted that unless the child attends to the stimulus he will be unable to determine its criterial properties and it is the differentiating of relevant from irrelevant dimensions of a stimulus that controls whether or not an adequate mental representation is encoded. If a good match can be made between a training procedure and learning

task, a different set of results might be obtained. Under these circumstances, it might be found that verbal prompts add little or nothing to the performance of preoperational stage children.

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Table 1

Means and Standard Deviations of Treatment Groups

For Number Correct

	Level of Concreteness					
Attentional	Low Detail		High Detail		High Detail & Verbal Prompt	
Training	Mean	SD	Mean	SD	Mean	SD
Trained	12.72	4.24	12.63	5.64	13.90	6.26
Untrained	12.36	5.74	13.90	5.00	10.72	4.88
Control	10.00	2.19	11.00	4.31	16.00	4.12